NCERT
Solutions
CHEMISTRY

Chapter 3 : Atoms And Molecules

Class
9

Questions:

Q. 1 In a reaction, 5.3 g of sodium carbonate reacted with 6 g ethanoic acid. The products were 2.2 g of carbon dioxide, o.9 g of water and 8.2 g of sodium ethanoate. Show that these observations are in agreement with the law of conservation of mass.

Sodium Carbonate + Acetic Acid → Sodium Acetate + Carbon Dioxide + Water

Ans.: In the given reaction, sodium carbonate reacts with acetic acid to produce sodium acetate, carbon dioxide, and water.

Sodium Carbonate + Acetic Acid → Sodium Acetate + Carbon Dioxide + Water

Mass of Sodium Carbonate = 5.3 g (Given)

Mass of Acetic Acid = 6 g (Given)

Mass of Sodium Acetate = 8.2 g (Given)

Mass of Carbon Dioxide = 2.2 g (Given)

Mass of Water = 0.9 g (Given)

Now, total mass before the reaction = Mass of (Sodium Carbonate + Acetic Acid) = (5.3 + 6) g

= 11.3 g

And, total mass after the reaction = Mass of (Sodium Acetate + Carbon Dioxide + Water) = (8.2 + 2.2 + 0.9) g

= 11.3 g

∴ Total mass before the reaction = Total mass after the reaction

Hence, the given observations are in agreement with the law of

conservation of mass.

Q.2 Hydrogen and oxygen combine in the ratio of 1 : 8 by mass to from water. What mass of oxygen gas would be required to react completely with 3 g of hydrogen gas?

Ans.: Here we have been given that hydrogen and oxygen always combine in the fixed ratio of 1 : 8 by mass. This means that:

1 g of hydrogen gas requires = 8 h of oxygen gas

So, 3 g of hydrogen gas requires = 8×3 g of oxygen gas

= 24 g of oxygen gas

Thus, 24 grams of oxygen gas would be required to react completely with 3 grams of hydrogen gas.

Q.3 Which postulate of Dalton's atomic theory is the result of the law of conservation of mass?

Ans.: The postulate of Dalton's atomic theory that is the result of the law of conservation of mass are following:

'Atoms are indivisible particles, which cannot be created or destroyed in a chemical reaction.'

'The relative number and kinds of atoms are constant in a given compound.'

Q.4 Which postulate of Dalton's atomic theory can explain the law of definite proportions?

Ans.: The postulate of Dalton's atomic theory that explains the law of definite proportions is 'The relative number and kinds of atoms are constant in a given compound.'

Questions:

Q. 1 Define the atomic mass unit.

Ans.: One atomic mass unit is a mass unit equal to exactly one twelveth (1/12th) the mass of one atom of carbon-12. The relative atomic masses of all elements have been found with respect to an atom of carbon-12.

**Q.2** Why is it not possible to see an atom with naked eyes?

Ans.: It is not possible to see an atom with naked eyes because an atom is a very small particle. For example, the radius of a hydrogen atom is 10^{-10} metre.

Questions:

Q. 1 Write down the formulae of:

(i) Sodium oxide

(ii) Aluminum chloride

(iii) Sodium sulphide

(iv) Magnesium hydroxide

Ans.: i) Sodium is an ionic compound made up of sodium ions and oxide ions. The sodium ion has a valency or charge of 1+ where is oxide Ion has a valency or charge of 2-
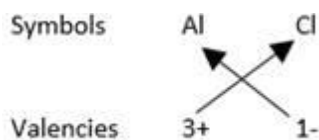
Symbol – Na   O
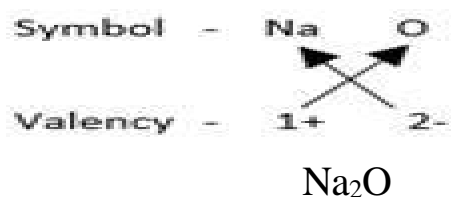
Valency – 1+   2-

Na_2O

Na O1+ 2- (cross over valencies)Formula: Na_2O
Hence, the formula of sodium oxide is Na_2O.
ii) Aluminium chloride is an ionic compound made up of aluminium ions and chloride ions. Aluminium Ion has a valency of 3+ whereas
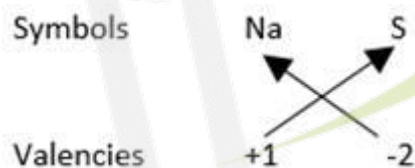
chloride Ion has a valency of 1-.

Symbols   Al   Cl

Valencies   3+   1-

$$AlCl_3 \ Or \ AlCl_3$$

Al Cl3+ 1- (cross over valencies)Formula: $AlCl_3$
Hence, the formula of aluminium chloride is $AlCl_3$.

iii) Sodium sulphide ionic compound made up of sodium ions and sulphide ions. Sodium Ion has a valency of 1+ ion has a valency of 2-

Symbols   Na   S

Valencies   +1   -2

Na S1+ 2- (cross over valencies)Formula: Na_2S
Hence, the formula of sodium sulphide is Na_2S.
iv) Magnesium hydroxide is an ionic compound made up of magnesium and Hydroxide ions. Magnesium iron has a valency of 2+ and Hydroxide has a valency of 1-

Symbols   Mg   OH
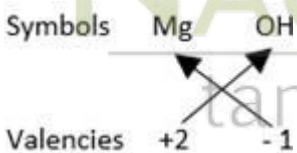
Valencies   +2   - 1

Mg OH2+ 1- (cross over valencies)Formula: $Mg(OH)_2$
Hence, the formula of magnesium hydroxide is $Mg(OH)_2$.

Q. 2 Write down the names of compounds represented by the following formulae:

(i) $Al_2(SO_4)3$
(ii) $CaCl_2$
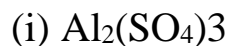
(iii) K_2SO_4

(iv) KNO_3

(v) $CaCO_3$

Ans.:

(i) The name of this compound is Aluminium sulphate.

(ii) The name of this compound is Calcium chloride.

(iii) The name of this compound is Potassium sulphate.

(iv) The name of this compound is potassium nitrate.

(v) The name of this compound is Calcium carbonate.

Q.3 What is meant by the term chemical formula?

Ans.: The chemical formula of a compound is a symbolic representation of its composition. The combining power or combining capacity of an element is known as its valency. Valency can be used to find out how the atoms of an element will combine with the atom(s) of another element to form a chemical compound. Some elements show more than one valency. Then we must crossover the valencies of the combining atoms. The positive and negative charges must balance each other and the overall structure must be neutral.

Q.4 How many atoms are present in a:

(i) H_2S molecule, and

(ii) PO_4^{3-} ion?

Ans.:

(i) There are three atoms in a H_2S molecule. Two hydrogen atoms and one sulphur.

(ii) There are five atoms present in a PO_4^{3-} ion. One phosphorus atom and four oxide ions.

Questions:

Q. 1 Calculate the molecular masses of H_2, O_2, Cl_2, CO_2, CH_4, C_2H_6, C_2H_4, NH_3, CH_3OH (Atomic masses: H = 1; O = 16; Cl = 35.5; C = 12; N = 14)

Ans.: The molecular mass of a substance is the sum of the atomic masses of all the atoms in a molecule of the substance. It is therefore the relative mass of a molecule expressed in atomic mass units (u).

(i) Atomic mass of Hydrogen = 1 u.

Molecular mass of H_2 = Mass of 2H atoms = 2 x 1 = 2 u

(ii) Atomic mass of Oxygen = 16 u

Molecular mass of O_2 = Mass of 2 'O' atoms = 2 X 16 = 32 u

(iii) Atomic mass of Cl = 35.5 u

Molecular mass of Cl_2 = Mass of 2Cl atoms = 2 X 35.5 = 71 u

(iv) In this molecule, there is one carbon atom and two oxygen atoms.

Atomic mass of Carbon = 12 u

Atomic mass of Oxygen = 16 u

Molecular mass of CO_2 = Mass of C atom + Mass of 2 'O' atoms

= 12 + 2 X 16 = 12 + 32 = 44 u

(v) Methane molecule has one carbon atom and four hydrogen atoms.

Atomic mass of Carbon = 12 u, Atomic mass of Hydrogen = 1 u

Molecular mass of CH_4 = Mass of C atom + Mass of 4H atoms

= 12 + 4 X 1 = 12 + 4 = 16 u

(vi) C_2H_6 molecule has two carbon atoms and six hydrogen atoms.

Atomic mass of Carbon = 12 u, Atomic mass of Hydrogen = 1 u

Molecular mass of C_2H_6 = Mass of 2C atoms + Mass of 6H atoms

= 2 X 12 + 6 X 1 = 24 + 6 = 30 u

(vii) C_2H_4 molecule has two carbon atoms and four hydrogen atoms.

C_2H_6 molecule has two carbon atoms and four hydrogen atoms.

Molecular mass of C_2H_4 = Mass of 2C atoms + Mass of 4 H atoms

= 2 X 12 + 4 X 1 = 24 + 4 = 28 u

(viii) NH_3 molecule has one nitrogen atom and three hydrogen atoms.

Atomic mass of Nitrogen = 14 , Atomic mass of hydrogen = 1 u

Molecular mass of NH_3 = Mass of N atom + Mass of 3H atoms

= 14 + 3 X 1 = 14 + 3 = 17 u

(ix) CH_3OH molecule has one carbon atom, four hydrogen atoms and one oxygen atom.

Atomic mass of carbon = n 12 u, Atomic mass of hydrogen = 1 u and Atomic mass of oxygen = 12 u.

Molecular mass of CH_3OH = Mass of C + Mass of 4 H + Mass of 0

= 12 + 4 X 1 + 16 = 12 + 4 + 16 = 32 u

Q. 2 Calculate the formula unit masses of ZnO, Na_2O, K_2CO_3

(Given: Atomic masses of Zn = 65 u; Na = 23 u; K = 39 u; C = 12u and O = 16 u)

Ans.: (i) Formula mass of ZnO = Mass of Zn atom + Mass of 0 atom

= 65 + 16 = 81 u

(ii) Formula mass of Na_2O = Mass of 2Na atoms + Mass of 0

$= 2 \times 23 + 16 = 46 + 16 = 62$ u

(iii) Formula mass of K_2CO_3 = Mass of two potassium atoms + one carbon atom + three oxygen atoms

$= 2 \times 39 + 12 + 3 \times 16 = 78 + 12 + 48 = 138$ u

Exercise

Questions:

Q. 1 A 0.24 g sample of compound of oxygen and boron was found by analysis to contain 0.096 g of boron and 0.144 g of oxygen. Calculate the percentage composition of the compound by weight.

Ans.: (i) Mass of boron in compound = 0.096 g

And, Mass of compound = 0.24 g

So, Percentage of Boron $= \dfrac{Mass\ of\ Boron\ in\ Compound}{Mass\ of\ compound} \times 100$

$= \dfrac{0.096}{0.24} \times 100$

$= 40\%$ …….(i)

(ii) Mass of oxygen in compound = 0.144 g

And, Mass of compound = 0.24 g

So, Percentage of oxygen $= \dfrac{Mass\ of\ Boron\ in\ Compound}{Mass\ of\ compound} \times 100$

$= \dfrac{0.144}{0.24} \times 100$

$= 60\%$ …….(ii)

Thus, the percentage composition of the compound is: Boron = 40%; Oxygen = 60%

Q. 2 When 3.0 g of carbon is burnt in 8.00 g of oxygen, 11.00 g of carbon dioxide is produced. What mass of carbon dioxide will be formed when 3.00 g of carbon is burnt in 50.00 g of oxygen? Which law of chemical combination will govern your answer?

Ans.: Answer will be governed by the law of constant proportions which states that the mass of reactant must be equal to the mass of the product formed during a reaction

Now, since carbon and oxygen combine in the fixed proportion of 3 : 8 by mass to produce 11 g of carbon dioxide,

$$C + O_2 = CO_2$$
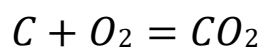
3 + 8 = 11 (by ratio proportion)According to the question, the equation formed will be:-

$$C + 2O_2 = CO_2 + O_2$$
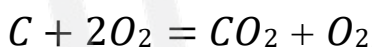
3 +50 = 11 + 42   53   =   53Therefore, the same mass of carbon dioxide (11 g) will be obtained even if we burn 3 g of carbon in 50 g of oxygen. The extra oxygen (50 − 8 = 42 g oxygen) will remain unchanged.

Q.3 What are polyatomic ions? Give examples.

Ans.: Polyatomic ions is the group of atom carrying positive or negative charge. For example,ammonium ion, NH^+, is a polyatomic ion which is made up of two types of atoms, nitrogen (N) and hydrogen (H) joined together.

Similarly,carbonate - CO_3^{2-} , sulphate -SO_4^{2-}, nitrate - NO_3^- and hydroxide ions OH⁻ are all polyatomic ions.

Q.4 Write the chemical formulae of the following:

(a) Magnesium chloride

(b) Calcium oxide

(c) Copper Nitrate

(d) Aluminium chloride

(e) Calcium carbonate

Ans.: (a) The chemical formula of a compound is a symbolic representation of its composition. The combining power or combining capacity of an element is known as its valency. Valency can be used to find out how the atoms of an element will combine with the atom(s) of another element to form a chemical compound. Some elements show more than one valency.
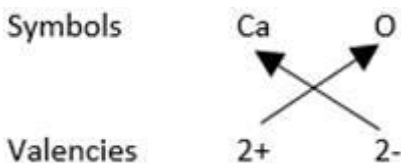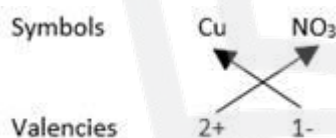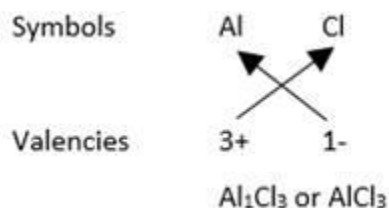
While writing the chemical formulae for compounds, we write the constituent elements or their symbols and their valencies as shown below. Then we must crossover the valencies of the combining atoms. The positive and negative charges must balance each other and the overall structure must be neutral.
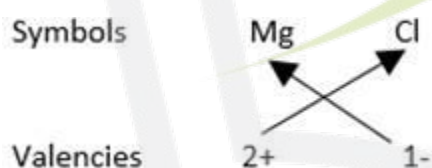
In magnesium chloride, there will be two chloride ions per one magnesium ion. Thus, the formula or magnesium chloride is $MgCl_2$.

(b) The chemical formula of a compound is a symbolic representation of its composition. The combining power or combining capacity of an element is known as its valency. Valency can be used to find out how the atoms of an element will combine with the atom(s) of another element to form a chemical compound. Some elements show more than one valency.

While writing the chemical formulae for compounds, we write the constituent elements or their symbols and their valencies as shown below. Then we must crossover the valencies of the combining atoms. The positive and negative charges must balance each other and the overall structure must be neutral.

Symbols   Ca   O

Valencies   2+   2-

Thus, the formula of Calcium Oxide is CaO.

(c) The chemical formula of a compound is a symbolic representation of its composition. The combining power or combining capacity of an element is known as its valency. Valency can be used to find out how the atoms of an element will combine with the atom(s) of another element to form a chemical compound. Some elements show more than one valency.

While writing the chemical formulae for compounds, we write the constituent elements or their symbols and their valencies as shown below. Then we must crossover the valencies of the combining atoms. The positive and negative charges must balance each other and the overall structure must be neutral.

Symbols   Cu NO_3

Valencies   2+   1-

Thus, the formula or copper nitrate is $Cu(NO_3)_2$

(d) The chemical formula of a compound is a symbolic representation of its composition. The combining power or combining capacity of an element is known as its valency. Valency can be used to find out how the atoms of an element will combine with the atom(s) of another element to form a chemical compound. Some elements show more than one valency.

While writing the chemical formulae for compounds, we write the constituent elements or their symbols and their valencies as shown below. Then we must crossover the valencies of the combining atoms. The positive and negative charges must balance each other and the overall structure must be neutral.

Symbols   Al   Cl

Valencies   3+   1-

Al_1Cl_3 or $AlCl_3$

In Aluminium Chloride, there are three chloride ions per one aluminium ion. Thus, the Aluminium chloride is $AlCl_3$.

(e) The chemical formula of a compound is a symbolic representation of its composition. The combining power or combining capacity of an element is known as its valency. Valency can be used to find out how the atoms of an element will combine with the atom(s) of another element to form a chemical compound. Some elements show more than one valency.

While writing the chemical formulae for compounds, we write the constituent elements or their symbols and their valencies as shown below. Then we must crossover the valencies of the combining atoms. The positive and negative charges must balance each other and the overall structure must be neutral.

Symbols   Ca CO_3

Valencies   2+   - 2
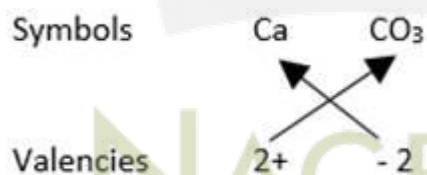
Thus, the formula or calcium carbonate is $CaCO_3$.

Q.5 Give the names of the elements present in the following compounds:

(a) Quick lime

(b) Hydrogen bromide

(c) Baking soda

(d) Potassium sulphate

Ans.:

(a) Calcium oxide, CaO is also known as quick lime. The elements present in quick lime are: Calcium (Ca) and Oxygen (O).

(b) The chemical formula of hydrogen bromide is HBr. The elements present in hydrogen bromide are: Hydrogen (H) and Bromine (Br).

(c) Baking soda is sodium hydrogen carbonate, and its chemical formula is $NaHCO_3$. The elements present in baking soda are: Sodium (Na), Hydrogen (H), Carbon (C) and Oxygen (O).

(d) The chemical formula of potassium sulphate is K_2SO_4. The elements present in potassium sulphate are: Potassium (K), Sulphur (S) and Oxygen (O).

Q. 6 Calculate the molar masses of the following substances:

(a) Ethyne, C_2H_2

(b) Sulphur molecule, S_8

(c) Phosphorus molecule, P_4

(d) Hydrochloric acid, HCl

(e) Nitric acid, HNO_3

Ans: The molar masses of all these substances will be equal to the respective molecular masses expressed in g/mol. Now:\(a) Molar mass of ethyne, C_2H_2 = Mass of C $\times$ 2 + Mass of H $\times$ 2

$= 12 \times 2 + 1 \times 2$

$= 24 + 2$

$= 26$ g/mol

(b) Molar mass of sulphur molecule, S_8 = Mass of S $\times$ 8

$= 32 \times 8$

$= 256$ g/mol

(c) Molar mass of phosphorus molecule, P_4 = Mass of P × 4

= 31 × 4

= 124 g/mol

(d) Molar mass of hydrochloric acid, HCl = Mass of H + Mass of Cl

= 1 + 35.5

= 36.5 g/mol

(e) Molar mass of nitric acid, HNO_3

= Mass of H + Mass of N + Mass of O × 3

= 1 + 14 + 16 × 3

= 15 + 48

= 63 g/mol

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SKILL MODULES BEING OFFERED IN MIDDLE SCHOOL

Artificial Intelligence

Beauty & Wellness

Design Thinking & Innovation

Financial Literacy

Handicrafts

Information Technology

Marketing/Commercial Application

Mass Media - Being Media Literate

Travel & Tourism

Coding
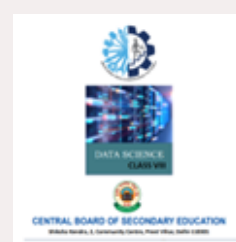
Data Science (Class VIII only)

Augmented Reality / Virtual Reality
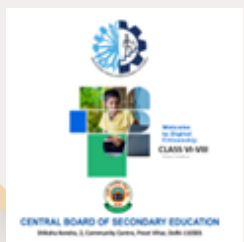
Digital Citizenship

Life Cycle of Medicine & Vaccine
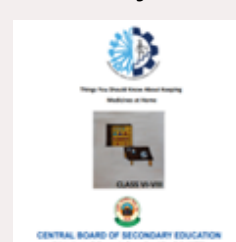
Things you should know about keeping Medicines at home

What to do when Doctor is not around
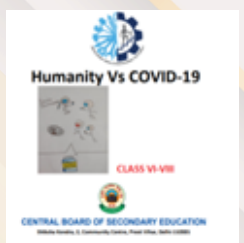
Humanity & Covid-19

Blue Pottery
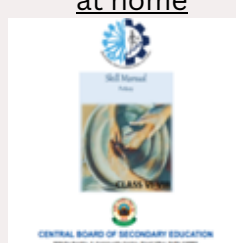
Pottery

Block Printing
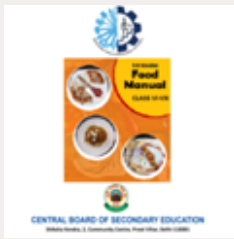
Food
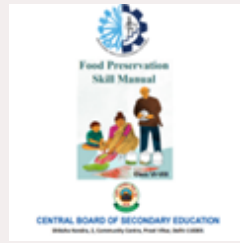
Food Preservation

Baking
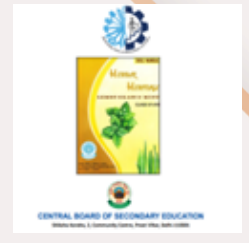
Herbal Heritage

Khadi
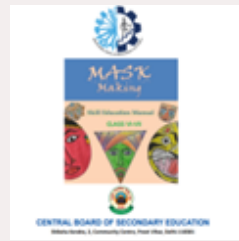
Mask Making

Mass Media

Making of a Graphic Novel
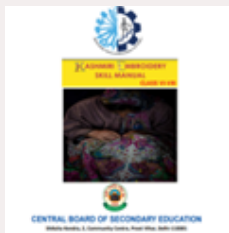
Kashmiri Embroidery

Embroidery

Rockets
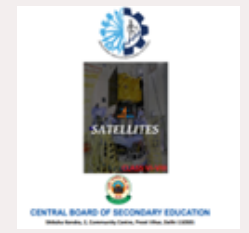
Satellites
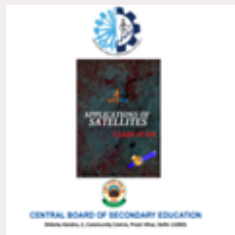
Application of Satellites

Photography

SKILL SUBJECTS AT SECONDARY LEVEL (CLASSES IX – X)

Retail
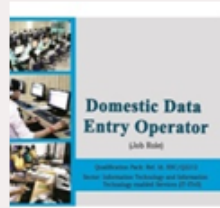
Information Technology

Security

Automotive

Introduction To Financial Markets
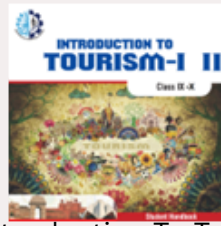
Introduction To Tourism
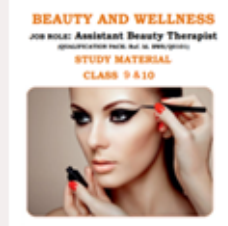
Beauty & Wellness

Agriculture

Food Production

Front Office Operations

Banking & Insurance

Marketing & Sales

Health Care

Apparel

Multi Media

Multi Skill Foundation Course

Artificial Intelligence

Physical Activity Trainer

Data Science

Electronics & Hardware (NEW)

Foundation Skills For Sciences (Pharmaceutical & Biotechnology)(NEW)

Design Thinking & Innovation (NEW)

SKILL SUBJECTS AT SR. SEC. LEVEL (CLASSES XI – XII)
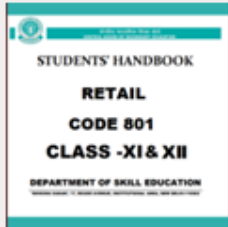
Retail
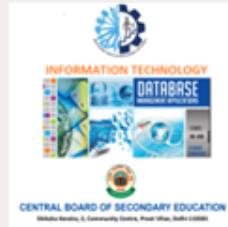
InformationTechnology

Web Application
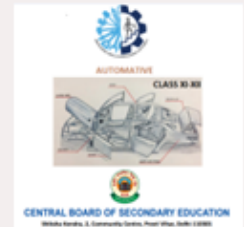
Automotive

Financial Markets Management

Tourism

Beauty & Wellness

Agriculture

Food Production

Front Office Operations

Banking

Marketing

Health Care

Insurance
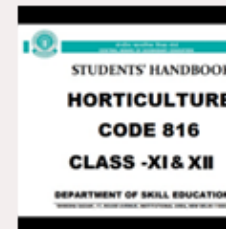
Horticulture
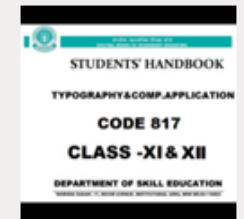
Typography & Comp. Application

Geospatial Technology
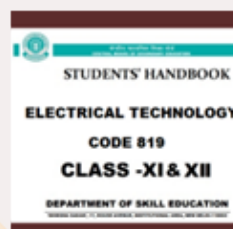
Electrical Technology

Electronic Technology
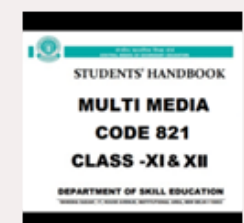
Multi-Media

Taxation	Cost Accounting	Office Procedures & Practices	Shorthand (English)
Shorthand (Hindi)	Air-Conditioning & Refrigeration	Medical Diagnostics	Textile Design
Design	Salesmanship	Business Administration	Food Nutrition & Dietetics
Mass Media Studies	Library & Information Science	Fashion Studies	Applied Mathematics
Yoga	Early Childhood Care & Education	Artificial Intelligence	Data Science
Physical Activity Trainer(new)	Land Transportation Associate (NEW)	Electronics & Hardware (NEW)	Design Thinking & Innovation (NEW)
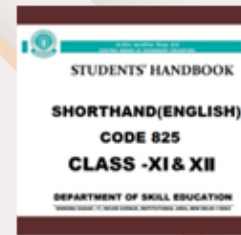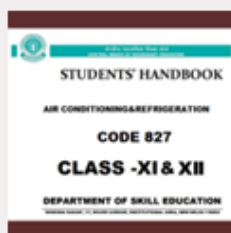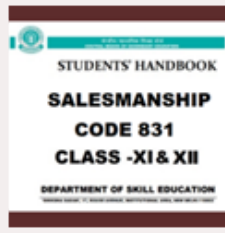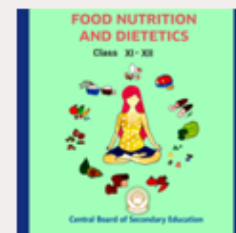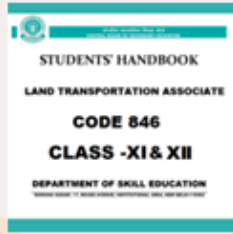
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Subject Wise Secondary and Senior Secondary Groups IX & X

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Hindi Core — Click Here to Join

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Political Science — Click Here to Join

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IP — Click Here to Join

Physical Education — Click Here to Join

APP. Mathematics — Click Here to Join

Legal Studies — Click Here to Join

Entrepreneurship — Click Here to Join

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Join us on Telegram
Class 11 (Com)

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Class 11 (Hum)

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Class 12 (Com)

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Class 12 (Hum)

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Kindergarten

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Class 4
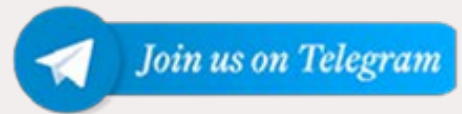
Class 5
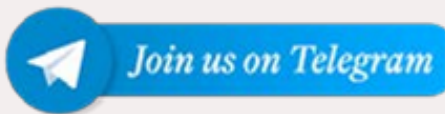
Class 6

Class 7
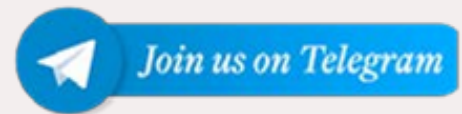
Class 8
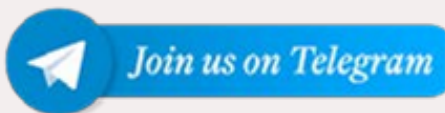
Class 9
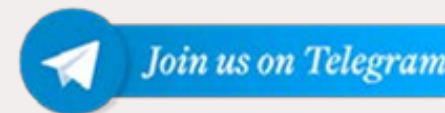
Class 10
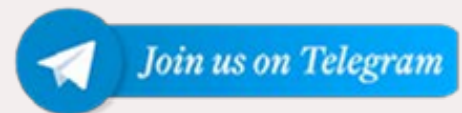
Class 11 (Sci)
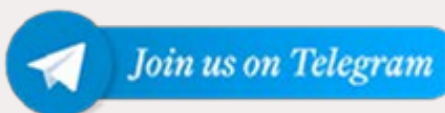
Class 11 (Com)
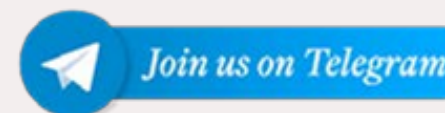
Class 11 (Hum)
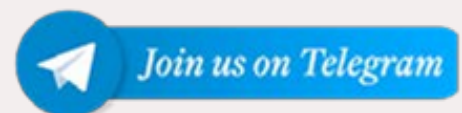
Class 12 (Sci)
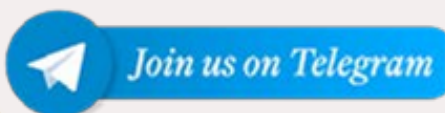
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